High-Performance Supercapacitors from Poultry Litter Super-Activated Biochar

Giacomo Magnani[1],
Daniele Pontiroli[1], Silvio Scaravonati[1], Laura Fornasini[1], Danilo Bersani[1], Giovanni Bertoni[2-3], Chiara Milanese[4], Alessandro Girella[4], Francesca Ridi[5], Roberto Verucchi[6], Luciana Mantovani[7], Alessio Malcevschi[7], Mauro Riccò[1]

1- Nanocarbon Laboratory, Dipartimento SMFI, Università di Parma, Parco Area delle Scienze 7/a, 43124 Parma, Italy
2- CNR - Istituto Nanoscienze, Via Campi 213/A, 41125 Modena, Italy
3- IMEM – CNR, Parco Area delle Scienze 37/A, 43124 Parma, Italy
4- Pavia Hydrogen Lab, C.S.G.I. & Dipartimento di Chimica, Università di Pavia, Viale Taramelli 16, 27100, Pavia, Italy
5- Dipartimento di Chimica "Ugo Schiff" & C. S. G. I., Università di Firenze, Via della Lastruccia, 3, 50019 Sesto Fiorentino (FI), Italy
6- IMEM – CNR, Trento unit, Via alla Cascata 56/C, 38123 Povo (Tn), Italy
7- Dipartimento di SCVSA, Università di Parma, Parco Area delle Scienze 11/a and 157/a, 43124 Parma, Italy

giacomo.magnani@unipr.it

Nowadays, growing energy demand and new technological frontiers require the study of supercapacitors (SCs) as devices able to fulfill these requests. In fact SCs are promising devices for energy conversion and storage, capable to bridge the gap between conventional capacitors and rechargeable batteries.
The most important energy storage mechanism in SCs arises from the reversible electrostatic charge accumulation at the surface of highly porous electrodes [1].
In particular, in this work we have studied activated biochar (BC) derived by the pyrolysis of organic industrial waste, poultry litter, as electrode material in symmetric supercapacitors.
We have chemically activated our BC with KOH [2], obtaining a hierarchically-porous super-activated carbon with specific surface area higher than 3000 m^2/g.
This chemical process has allowed to remove the impurities other than carbon, stabilizing a highly porous hierarchical structure with local graphene-like morphology.
The as-synthesized material has presented very good electrical conductivity, together with an optimized pore size distribution, allowing us to use it directly as electrode in symmetric supercapacitors without any conducting additives, operating with simple eco-friendly electrolytes, like KOH and Na_2SO_4 aqueous solutions.
In detail, this "all green" supercapacitor devices have supplied high current density of 10 A/g without using any conducting additives, displaying high power density and reliability, reaching high specific capacitance up to 229(13) F/g [3].
In conclusion these carbon based devices disclose to direct large scale applications, for example in the field of transportation or in renewable energy-grids, but also in the field of bio-medicine, thanks to their properties of availability, biocompatibility and inexpensiveness of the starting materials, together with the low environmental impact of the electrolyte.

References

[1] E. Frackowiak, F. Béguin, Carbon, 39 (2001) 937-950.

[2] X. Zhang, X. Cui and W. Chen, RSC Adv., 5 (2015) 77629

[3] D. Pontiroli, S. Scaravonati, G. Magnani, L. Fornasini, D. Bersani, G.i Bertoni, C. Milanese, A. Girella, F. Ridi, R. Verucchi , L. Mantovani, A. Malcevschi, M. Riccò, (2019) submitted